AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claim 1 (currently amended): A method of automatically analyzing ~~at least one seedling~~ a plurality of seedlings germinated from ~~at least one seed~~ a plurality of seeds, comprising ~~the steps of~~:

    ~~(a)~~   capturing a digital image of each of the plurality of seedlings ~~the at least one seedling~~;

    ~~(b)~~   identifying each of the plurality of seedlings ~~the at least one seedling~~ in the captured digital image;

    ~~(c)~~   determining a primary path of each of the plurality of seedlings ~~the at least one seedling~~;

    ~~(d)~~   determining at least one value from the primary path of each of the plurality of seedlings ~~the at least one seedling~~; and

    ~~(e)~~   determining a seed vigor index from at least the values ~~at least one value~~ determined from the primary path of each of the plurality of seedlings ~~the at least one seedling~~.

Claim 2 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 1, wherein:

    ~~(a)~~   ~~wherein said step of~~ determining at least one value from the primary path of each of the plurality of seedlings ~~the at least one seedling~~ comprises the step of determining a value corresponding to an overall length of each of the plurality of seedlings ~~the at least one seedling~~ from the primary path of each of the plurality of seedlings ~~the at least one seedling~~; and

    ~~(b)~~   ~~wherein said step of~~ determining a seed vigor index from at least the values ~~at least one value~~ determined from the primary path of each of the plurality of seedlings includes ~~the at least one seedling comprises the step of~~ determining a

seed vigor index from at least the value corresponding to the overall length of each of the plurality of seedlings ~~the at least one seedling~~.

Claim 3 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 1 further comprising ~~the step of~~ determining a separation point between the hypocotyl ~~of the at least one seedling~~ and the radicle of each of the plurality of seedlings ~~the at least one seedling~~; and:

    ~~(a)~~ wherein ~~said step of~~ determining at least one value from the primary path of each of the plurality of seedlings ~~the at least one seedling~~ comprises ~~the step of~~ determining a value corresponding to the length of at least one of the hypocotyl ~~of the at least one seedling~~ and the radicle of each of the plurality of seedlings ~~the at least one seedling~~; and

    ~~(b)~~ wherein ~~said step of~~ determining a seed vigor index from at least the values ~~at least one value~~ determined from the primary path of each of the plurality of seedlings ~~the at least one seedling~~ comprises ~~the step of~~ determining a seed vigor index from at least the value corresponding to the length of at least one of the hypocotyl ~~of the at least one seedling~~ and the radicle of each of the plurality of seedlings ~~the at least one seedling~~.

Claim 4 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 1 further comprising ~~the step of~~ determining a separation point between the hypocotyl ~~of the at least one seedling~~ and the radicle of each of the plurality of seedlings ~~the at least one seedling~~; and:

    ~~(a)~~ wherein ~~said step of~~ determining at least one value from the primary path of each of the plurality of seedlings ~~the at least one seedling~~ comprises ~~the step of~~ determining a hypocotyl length value corresponding to the length of the hypocotyl of each of the plurality of seedlings ~~the at least one seedling~~ and a radicle length value corresponding to the length of the radicle of each of the plurality of seedlings ~~the at least one seedling~~; and

    ~~(b)~~ wherein ~~said step of~~ determining a seed vigor index from at least the values ~~at least one value~~ determined from the primary path of each of the plurality of

seedlings ~~the at least one seedling~~ comprises ~~the step of~~ determining a seed vigor index from at least the hypocotyl length value and the radicle length value.

Claim 5 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 1 wherein ~~said step of~~ determining a primary path of <u>each of the plurality of seedlings</u> ~~the at least one seedling~~ comprises ~~the step of~~ determining <u>for each seedling</u> a locus of pixels, the locus of pixels corresponding to the primary path of the <u>respective</u> ~~at least one~~ seedling and the locus of pixels being narrower in width than the width of the <u>respective</u> ~~at least one~~ seedling in the digital image of the <u>respective</u> ~~at least one~~ seedling.

Claim 6 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 1 wherein ~~said step of~~ determining a primary path of <u>each of the plurality of seedlings</u> ~~the at least one seedling~~ comprises ~~the step of~~ determining <u>for each of the plurality of seedlings</u> a locus of pixels, the locus of pixels corresponding to the primary path of the <u>respective</u> ~~at least one~~ seedling and the locus of pixels being a predetermined number of pixels in width.

Claim 7 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 1 wherein ~~said step of~~ determining a primary path of <u>each of the plurality of seedlings</u> ~~the at least one seedling~~ comprises ~~the step of~~ determining <u>for each of the plurality of seedlings</u> a locus of pixels, the locus of pixels corresponding to the primary path of the <u>respective</u> ~~at least one~~ seedling and the locus of pixels being one pixel in width.

Claim 8 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 1 further comprising ~~the step of~~ separately identifying a plurality of overlapped seedlings in the digital image of ~~the~~ at least one <u>of the plurality of seedlings</u> ~~seedling~~, and<u>:</u>

  ~~(a)~~ wherein ~~said step of~~ determining a primary path of the at least one seedling comprises ~~the step of~~ determining a primary path for each of the separately identified overlapped seedlings;

(b)   wherein said step of determining at least one value from the primary path of the at least one seedling comprises the step of determining from the primary path for each of the separately identified overlapped seedlings a <u>length</u> value corresponding to an overall length of that separately identified overlapped seedling; and

(c)   wherein said step of determining a seed vigor index from at least the <u>values</u> at least one value determined from the primary path of the at least one seedling comprises the step of determining a seed vigor index from at least the <u>length values</u> plurality of values determined in step (b).

Claim 9 (currently amended): The method of automatically analyzing at least one seedling according to claim 1 further comprising the step of separately identifying a plurality of overlapped seedlings in the digital image of the at least one <u>of the plurality of seedlings</u> seedling, and:

(a)   wherein said step of determining a primary path of the at least one seedling comprises the step of determining a primary path for each of the separately identified overlapped seedlings;

(b)   wherein said step of determining at least one value from the primary path of the at least one seedling comprises the step of determining from the primary path for each of the separately identified overlapped seedlings a <u>length</u> value corresponding to the length of at least one of the hypocotyl of that separately identified overlapped seedling and the radicle of that separately identified overlapped seedling; and

(c)   wherein said step of determining a seed vigor index from at least the <u>values</u> at least one value determined from the primary path of the at least one seedling comprises the step of determining a seed vigor index from at least the <u>length values</u> plurality of values determined in step (b).

Claim 10 (currently amended): The method of automatically analyzing at least one seedling according to claim 1 further comprising the step of separately identifying a plurality of

overlapped seedlings in the digital image of ~~the~~ at least one <u>of the plurality of seedlings</u> ~~seedling~~, and<u>:</u>

    ~~(a)~~   wherein ~~said step of~~ determining a primary path of the at least one seedling comprises ~~the step of~~ determining a primary path for each of the separately identified overlapped seedlings;

    ~~(b)~~   wherein ~~said step of~~ determining at least one value from the primary path of the at least one seedling comprises ~~the step of~~ determining from the primary path for each of the separately identified overlapped seedlings a hypocotyl length value corresponding to the length of the hypocotyl of that separately identified overlapped seedling and a radicle length value corresponding to the length of the radicle of that separately identified overlapped seedling; and

    ~~(c)~~   wherein ~~said step of~~ determining a seed vigor index from at least the <u>values</u> ~~at least one value~~ determined from the primary path of <u>each of the plurality of seedlings</u> ~~the at least one seedling~~ comprises ~~the step of~~ determining a seed vigor index from at least the plurality of hypocotyl length values ~~determined in step (b)~~ and at least the plurality of radicle length values ~~determined in step (b)~~.

Claim 11 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 8 wherein ~~said step of~~ separately identifying a plurality of overlapped seedlings in the digital image of ~~the~~ at least one seedling comprises evaluating an energy function.

Claim 12 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 9 wherein ~~said step of~~ separately identifying a plurality of overlapped seedlings in the digital image of ~~the~~ at least one seedling comprises evaluating an energy function.

Claim 13 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 10 wherein ~~said step of~~ separately identifying a plurality of overlapped seedlings in the digital image of ~~the~~ at least one seedling comprises evaluating an energy function.

Claim 14 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 8 wherein ~~said step of~~ separately identifying a plurality of overlapped seedlings in the digital image of ~~the~~ at least one seedling comprises evaluating an energy function based on proposed configurations of at least partial primary paths of overlapped seedlings.

Claim 15 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 9 wherein ~~said step of~~ separately identifying a plurality of overlapped seedlings in the digital image of ~~the~~ at least one seedling comprises evaluating an energy function based on proposed configurations of at least partial primary paths of overlapped seedlings.

Claim 16 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 10 wherein ~~said step of~~ separately identifying a plurality of overlapped seedlings in the digital image of ~~the~~ at least one seedling comprises evaluating an energy function based on proposed configurations of at least partial primary paths of overlapped seedlings.

Claim 17 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 8 wherein ~~said step of~~ separately identifying a plurality of overlapped seedlings in the digital image of ~~the~~ at least one seedling comprises evaluating an energy function based on proposed configurations of at least partial primary paths of overlapped seedlings using the following heuristics: primary paths do not make unnaturally sharp turns and seedling edges should be used as much as possible.

Claim 18 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 9 wherein ~~said step of~~ separately identifying a plurality of overlapped seedlings in the digital image of ~~the~~ at least one seedling comprises evaluating an energy function based on proposed configurations of at least partial primary paths of overlapped

seedlings using the following heuristics: primary paths do not make unnaturally sharp turns and seedling edges should be used as much as possible.

Claim 19 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 10 wherein ~~said step of~~ separately identifying a plurality of overlapped seedlings in the digital image of ~~the~~ at least one seedling comprises evaluating an energy function based on proposed configurations of at least partial primary paths of overlapped seedlings using the following heuristics: primary paths do not make unnaturally sharp turns and seedling edges should be used as much as possible.

Claim 20 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 8 wherein ~~said step of~~ separately identifying a plurality of overlapped seedlings in the digital image of ~~the~~ at least one seedling comprises evaluating an energy function based on proposed configurations of at least partial primary paths of overlapped seedlings using the following heuristics: primary paths should not make unnaturally sharp turns, seedling edges should be used as much as possible, and all primary axes should have a ~~hypocotyl/radicle~~ separation point <u>between the hypocotyl and the radicle</u>.

Claim 21 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 9 wherein ~~said step of~~ separately identifying a plurality of overlapped seedlings in the digital image of ~~the~~ at least one seedling comprises evaluating an energy function based on proposed configurations of at least partial primary paths of overlapped seedlings using the following heuristics: primary paths should not make unnaturally sharp turns, seedling edges should be used as much as possible, and all primary axes should have a ~~hypocotyl/radicle~~ separation point <u>between the hypocotyl and the radicle</u>.

Claim 22 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 10 wherein ~~said step of~~ separately identifying a plurality of overlapped seedlings in the digital image of ~~the~~ at least one seedling comprises evaluating an energy function based on proposed configurations of at least partial primary paths of overlapped seedlings using the following heuristics: primary paths should not make unnaturally sharp turns,

seedling edges should be used as much as possible, and all primary axes should have a ~~hypocotyl/radicle~~ separation point <u>between the hypocotyl and the radicle</u>.

Claim 23 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 1 further comprising: ~~the steps of~~

determining a first locus of points indicating the hypocotyl of ~~the~~ at least one seedling~~;~~:

determining a second locus of points indicating the radicle of the at least one seedling~~;~~:

overlaying the first and second loci over an image of the seedlings to generate a composite image~~;~~: and

displaying the composite image.

Claim 24 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 23 wherein ~~said step of~~ displaying the composite image comprises ~~the step of~~ displaying the composite image on a video display terminal.

Claim 25 (currently amended): The method of ~~automatically analyzing at least one seedling according to~~ claim 23 wherein ~~said step of~~ displaying the composite image comprises ~~the step of~~ printing the image on a printer or plotter.

Claim 26 (withdrawn): A method of automatically analyzing at least one seedling germinated from at least one seed, comprising the steps of:

(a)   capturing a digital image of the at least one seedling;

(b)   determining a first locus of points indicating the hypocotyl of the at least one seedling;

(c)   determining a second locus of points indicating the radicle of the at least one seedling;

(d)   overlaying the first and second loci over an image of the seedlings to generate a composite image; and

(e)   displaying the composite image.

Claim 27 (withdrawn): A method of analyzing at least one seedling germinated from at least one seed, comprising the steps of:

(a)   placing a growing medium in a shallow container;

(b)   wetting the growing medium;

(c)   placing the at least one seed onto the growing medium;

(d)   germinating the at least one seed with the shallow container at an angle with respect to the vertical that is less than about 10°;

(e)   capturing a digital image of the at least one seedling; and

(f)   analyzing the captured digital image of the germinated seedling.

Claim 28 (withdrawn): The method of analyzing at least one seedling according to claim 1 wherein said step of germinating the at least one seed with the shallow container at an angle with respect to the vertical that is less than about 10° comprises the step of positioning the shallow container vertically.

Claim 29 (withdrawn): The method of analyzing at least one seedling according to claim 1 wherein said step of capturing a digital image of the at least one seedling comprises capturing an image of the at least one seedling using a scanner having a scanner surface and positioned with its scanner surface oriented at least 90° from the horizontal.

Claim 30 (withdrawn): The method of analyzing at least one seedling according to claim 1 wherein said step of capturing a digital image of the at least one seedling comprises capturing an image of the at least one seedling using a scanner having a scanner surface and positioned with its scanner surface substantially inverted so that it captures an image of at least one seedling positioned beneath the scanner.

Claim 31 (newly added): A method of automatically analyzing a plurality of seedlings germinated from a plurality of seeds, comprising:

        capturing a digital image of each of the plurality of seedlings;

        identifying each of the plurality of seedlings in the captured digital image;

        determining a primary path of each of the plurality of seedlings;

        determining a separation point between the hypocotyl and the radicle of each of the plurality of seedlings;

determining a hypocotyl length value corresponding to the length of the hypocotyl of each of the plurality of seedlings and a radicle length value corresponding to the length of the radicle of each of the plurality of seedlings; and

determining a seed vigor index from at least the hypocotyl length value and the radicle length value.

Claim 32 (newly added): A method of automatically analyzing a plurality of seedlings germinated from a plurality of seeds, comprising:

capturing a digital image of each of the plurality of seedlings;

identifying each of the plurality of seedlings in the captured digital image;

determining a primary path of each of the plurality of seedlings including determining for each of the plurality of seedlings a locus of pixels, the locus of pixels corresponding to the primary path of the respective seedling and the locus of pixels being one pixel in width.;

determining at least one value from the primary path of each of the plurality of seedlings; and

determining a seed vigor index from at least the values determined from the primary path of each of the plurality of seedlings.

Claim 33 (newly added): A method of automatically analyzing a plurality of seedlings germinated from a plurality of seeds, comprising:

capturing a digital image of each of the plurality of seedlings;

identifying a plurality of overlapped seedlings in the digital image of at least one of the plurality of seedlings, and:

determining a primary path of each of the overlapped seedlings

determining from the primary path for each of the overlapped seedlings a length value corresponding to an overall length of that overlapped seedling; and

determining a seed vigor index from at least the length values of each of the overlapped seedlings.

Claim 34 (newly added): A method of automatically analyzing a plurality of seedlings germinated from a plurality of seeds, comprising:

    capturing a digital image of each of the plurality of seedlings;

    identifying a plurality of overlapped seedlings in the digital image of at least one of the plurality of seedlings, and:

    determining a primary path of each of the overlapped seedlings

    determining from the primary path for each of the overlapped seedlings a length value corresponding to the length of at least one of the hypocotyl of that separately identified overlapped seedling and the radicle of that separately identified overlapped seedling; and

    determining a seed vigor index from at least the length values of each of the overlapped seedlings.

Claim 35 (newly added): A method of automatically analyzing a plurality of seedlings germinated from a plurality of seeds, comprising:

    capturing a digital image of each of the plurality of seedlings;

    identifying a plurality of overlapped seedlings in the digital image of at least one of the plurality of seedlings, and:

    determining a primary path of each of the overlapped seedlings

    determining from the primary path for each of the overlapped seedlings a hypocotyl length value corresponding to the length of the hypocotyl of that overlapped seedling and a radicle length value corresponding to the length of the radicle of that overlapped seedling; and

    determining a seed vigor index from at least the plurality of hypocotyl length values and at least the plurality of radicle length values.

Claim 36 (newly added): The method of claim 33 wherein identifying a plurality of overlapped seedlings in the digital image of at least one seedling comprises evaluating an energy function.

Claim 37 (newly added): The method of claim 34 wherein identifying a plurality of overlapped seedlings in the digital image of at least one seedling comprises evaluating an energy function.

Claim 38 (newly added): The method of claim 35 wherein identifying a plurality of overlapped seedlings in the digital image of at least one seedling comprises evaluating an energy function.

Claim 39 (newly added): The method of claim 33 wherein identifying a plurality of overlapped seedlings in the digital image of at least one seedling comprises evaluating an energy function based on proposed configurations of at least partial primary paths of overlapped seedlings.

Claim 40 (newly added): The method of claim 34 wherein identifying a plurality of overlapped seedlings in the digital image of at least one seedling comprises evaluating an energy function based on proposed configurations of at least partial primary paths of overlapped seedlings.

Claim 41 (newly added): The method of claim 35 wherein identifying a plurality of overlapped seedlings in the digital image of at least one seedling comprises evaluating an energy function based on proposed configurations of at least partial primary paths of overlapped seedlings.

Claim 42 (newly added): The method of claim 33 wherein identifying a plurality of overlapped seedlings in the digital image of at least one seedling comprises evaluating an energy function based on proposed configurations of at least partial primary paths of overlapped seedlings using the following heuristics: primary paths do not make unnaturally sharp turns and seedling edges should be used as much as possible.

Claim 43 (newly added): The method of claim 34 wherein identifying a plurality of overlapped seedlings in the digital image of at least one seedling comprises evaluating an energy function based on proposed configurations of at least partial primary paths of overlapped seedlings using the following heuristics: primary paths do not make unnaturally sharp turns and seedling edges should be used as much as possible.

Claim 44 (newly added): The method of claim 35 wherein identifying a plurality of overlapped seedlings in the digital image of at least one seedling comprises evaluating an energy function based on proposed configurations of at least partial primary paths of overlapped seedlings using

the following heuristics: primary paths do not make unnaturally sharp turns and seedling edges should be used as much as possible.

Claim 45 (newly added): The method of claim 33 wherein identifying a plurality of overlapped seedlings in the digital image of at least one seedling comprises evaluating an energy function based on proposed configurations of at least partial primary paths of overlapped seedlings using the following heuristics: primary paths should not make unnaturally sharp turns, seedling edges should be used as much as possible, and all primary axes should have a separation point between the hypocotyl and the radicle.

Claim 46 (newly added): The method of claim 34 wherein identifying a plurality of overlapped seedlings in the digital image of at least one seedling comprises evaluating an energy function based on proposed configurations of at least partial primary paths of overlapped seedlings using the following heuristics: primary paths should not make unnaturally sharp turns, seedling edges should be used as much as possible, and all primary axes should have a separation point between the hypocotyl and the radicle.

Claim 47 (newly added): The method of claim 35 wherein identifying a plurality of overlapped seedlings in the digital image of at least one seedling comprises evaluating an energy function based on proposed configurations of at least partial primary paths of overlapped seedlings using the following heuristics: primary paths should not make unnaturally sharp turns, seedling edges should be used as much as possible, and all primary axes should have a separation point between the hypocotyl and the radicle.

Claim 48 (newly added): A method of automatically analyzing a plurality of seedlings germinated from a plurality of seeds, comprising:
    capturing a digital image of each of the plurality of seedlings;
    identifying each of the plurality of seedlings in the captured digital image;
    determining a primary path of each of the plurality of seedlings;
    determining at least one value from the primary path of each of the plurality of seedlings;

determining a seed vigor index from at least the values determined from the primary path
of each of the plurality of seedlings;

determining a first locus of points indicating the hypocotyl of at least one seedling;

determining a second locus of points indicating the radicle of the at least one seedling;

overlaying the first and second loci over an image of the seedlings to generate a
composite image; and

displaying the composite image

Claim 49 (newly added): The method of claim 48 wherein displaying the composite image
comprises displaying the composite image on a video display terminal.

Claim 50 (newly added): The method of claim 48 wherein displaying the composite image
comprises printing the image on a printer or plotter.

Claim 51 (newly added): A method of automatically analyzing a plurality of seedlings
germinated from a plurality of seeds, comprising:

providing a plurality of seedlings pressed into blotter paper disposed at angle as nearly
vertical as practical;

capturing a digital image of each of the plurality of seedlings;

identifying each of the plurality of seedlings in the captured digital image;

determining a primary path of each of the plurality of seedlings;

determining at least one value from the primary path of each of the plurality of seedlings;
and

determining a seed vigor index from at least the values determined from the primary path
of each of the plurality of seedlings.